

## **Adapting the concept of Napier's bones to teach multiplication for elementary students**

**Muh Wildanul Firdaus  
Sri Andayani**

*Mathematics Education Department  
Yogyakarta State University*

### **Abstract**

Napier's bones is a tool created by John Napier for calculating a products and quotients of numbers. The tool was used as a basic of designing the operation concept in creating early computer. The tool can conduct multiplication, division, and compute square root. In this paper we are focused on multiplication.

Based on the concept of Napier's bones, we can adopt it to teach multiplication for elementary students. The concept is simple and easy to be applied for elementary school students, because there are so many problems in elementary school related to multiplication. It will make the teaching and learning of mathematics to be more interesting.

**Keyword:** Napier's bones, teach multiplication, interesting, elementary students.

### **I. INTRODUCTION**

Mathematics is one subject that is quite feared and hated by elementary students. The fear of anything to do with numbers is embedded in not just children but also adults. However, the fault lies not with this subject, but with the teaching methods used to convey it. It can be caused by the way of teachers in introducing mathematics to their students. In teaching learning process, teachers which only teach conventionally will make their students saturated, and instill feeling of dislike of mathematics.

Teaching mathematics to elementary students is critical for establishing a foundation of success in mathematics. There is a need for some basic memorization of facts, because students who do not memorize arithmetic functions struggle in upper grades. Therefore, teaching mathematics must be fun and interesting.

Mathematics should be fun and interesting. When students become involved in mathematics learning, they retain more than just memorization of mathematics facts. Instead of just using worksheets and completing problems on the board, teacher should make mathematics fun and challenging.

Multiplication is one basic operation in mathematics that becomes the main of doing mathematics. There are so many problems in mathematics that need multiplication in solving it. Fifth and sixth grade teachers who are looking for a fun and easy way to help their students learn the multiplication should try some ideas to teach multiplication, so that the students having interest on mathematics.

Many students struggle to memorize multiplication facts, so here is a simple idea about the concept of Napier's bones modified for multiplication. Teacher can modify the concept to teach multiplication in elementary school.

## DISCUSSION

### A. History of Napier's Bones

Napier's bones is an abacus created by John Napier for calculation of products and quotients of numbers. Napier published his version of rods in a work printed in Edinburgh, Scotland, at the end of 1617 entitled *Rabdologiae*. The tool was used as a basic of designing the operation concept in creating early computer. It's become the second generation of computer after abacus. The tool can conduct multiplication that can be reduced to addition operations and division to subtractions. More advanced use of the rods can even extract square roots.

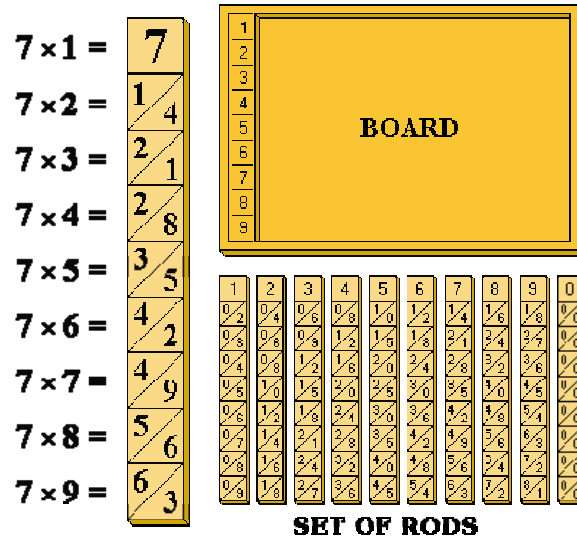


Figure 1. Napier's bones (<http://en.wikipedia.org>)

Napier's bone is ancient calculator. It's the second generation of computer, as we know the first is abacus. It consists of a board with a rim, the user places

Napier's rods in the rim to conduct multiplication or division. The board's left edge is divided into 9 squares, holding the numbers 1 to 9. The Napier's rods consist of strips of wood, metal or heavy cardboard. Napier's bones is three dimensional, squares in cross section, with four different rods engraved on each one.

From figure 1 is known that each rod consists of 9 squares split by diagonal into upper and lower section. Each squares consists a number as result of multiplication the number of rod with number 1 to 9. The upper section holds the tens of the multiplication, and the lower holds the unit.

#### B. How to Use the Napier's Bone

Given the described set of rods, suppose that we wish to calculate the product of 24 and 8. Place inside the board the rods corresponding to 24, as shown in the diagram, and read the result in the horizontal strip in row 8, as marked on the side of the board. To obtain the product, simply note, for each place from right to left, the numbers found by adding the digits within the diagonal sections of the strip (using carry-over where the sum is 10 or greater).

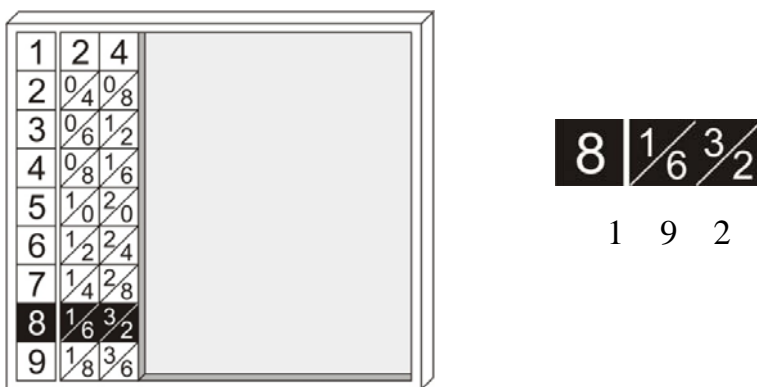


Figure 2. 24 x 8 using Napier's Bones

From right to left, we obtain the units place (2), the tens (6+3=9), the hundreds (1). We get the result is 192.

Let's try for other example, e.g. 42 x 358. Now we try using Napier's bones directly. Note that we must put 2 rods, i.e. 4 and 2 on the boards, as shown in the picture below. Then, we do addition to the number that separate by diagonal. So, we get  $1(2+2)(3+1+6)(2+1)6 = 15036$ .

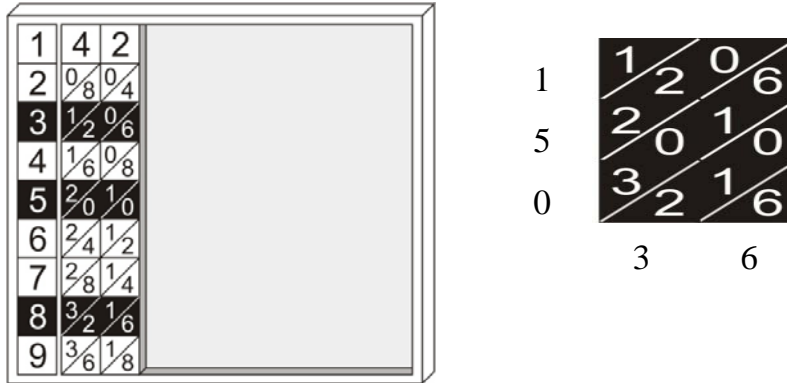


Figure 3. 42 x 358 using Napier's Bones

The basic of this concept is by making group among the numbers written in the rod. Look at bottom right corner from the second example, you will find 6 at the bottom right corner. This number shows that it-self is a unit. Then the next, 2 1 0 is a tens, where 3 0 1 6 is a hundreds, that we must do summation on it. Also 2 2 0 and the last is 1 at the top right corner.

C. Adapting the Concept of Napier's Bones

We do not have to create the tool to teach the multiplication. We just only need to adopt the concept of Napier's bones. We need to draw a table as the figure – the size of table is depending on the number the digit. Here are the steps to use the concept to teach multiplication.

For example, we will solve 57 x 93 using the concept of Napier's bones.

1. Draw two columns to put the number 5 and 7 to represent 57

5	7
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2. Draw third column to put the number 9 and 3 to represent 93 vertically, as shown below

5	7	
		9
		3

3. Draw a diagonal line across each empty squares

5	7	
/	/	9
/	/	3

4. Multiply 5 by 9, and put the results into the appropriate square, that is below 5 and the left of 9. Put the ten into upper section and the unit into the lower.

$5 \times 9 = 45$   $\rightarrow$

5	7	
4 5	/	9
/	/	3

5. Repeat step 4, to fill the other square, so we get a table as shown below.

5	7	
4 5	6 3	9
1 5	2 1	3

6. Add the numbers in each diagonal from the right to the left. If there is a carrying number, put the carry to the left diagonal

	5	7	
	1	1	carry over
	4	6	9
5	5	3	
3	1	2	3
	5	1	
0	1		

Figure 4. Applying concept of Napier's bones to solve  $57 \times 93$

7. So we get the result is 5301.

This step also works for larger numbers, for example  $3973 \times 572$ . The result of multiplication is 2,272,556 and the table is shown as follows.

		3	9	7	3	
2	1	4	3	1		5
	5	5	5	5		
2	2	6	4	2		7
	1	3	9	1		
7	0	1	1	0		2
	6	8	4	6		
	2	5	5	6		

Figure 5. Applying concept of Napier’s bones to solve  $3973 \times 572$

From the two examples above we can conclude that performing multiplication using the steps is more easy than usual. However, there are several requirements that must be mastered for students to complete the multiplication by using the concept. The requirement is that students have mastered the multiplication below 100 and students can add multiple numbers using carry-over where the sum is 10 or greater.

Based on the conditions, the multiplication using the technique of Napier's bone is suitable for students in the fifth and sixth grade.

## II. CONCLUSION AND SUGGESTION

Conventional method of teaching is not enough in teaching learning process in mathematics, moreover in elementary school. Mathematics teacher needs a technique to create learn mathematics more interesting, to prevent student bored and having feeling of dislike of mathematics.

Napier’s bones concept can be adopted as a technique to teach multiplication for students in the fifth and sixth grade that makes mathematics become interesting. This concept needs requirement i.e. students have mastered multiplication one through ten and addition which has carry-over. However, the concept is more easy

and fun for students than the usual technique. Furthermore, this technique can also be used for students at higher levels.

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